List of experiments useful for understanding of high-energy e-cooling (Dec. 11, 2003)

Objective:

1. To use available electron cooler rings to study parameter range relevant for high-energy electron cooling by scaling of various parameters appropriately: changing magnetic field strength and temperatures of electron beam).

2. To benchmark calculation of Friction Force using various approaches: Vorpal (direct numerical calculation), Betacool (analytic formulas) and Simcool (empiric formulas) via experiments.

Possible experiments:

A Measurement of Longitudinal Cooling Force as a function of relative ion velocity:

+A.1 Dependence of F_max on Δ_e_longitudinal – to study maximum of cooling force - possible/typical procedure/can have well controlled experiment.

+/-A.2 Dependence on Δ_e_transverse – to confirm that increase of transverse electron temperature has very small effect on cooling, provided that condition of good magnetization is maintained – can vary radius of electron beam.

+/-A.3 Dependence on magnetic field in the range of parameters corresponding to "good" and "bad" magnetization – to be checked (by Oliver) about independent power supplies or different shunt impedance, etc. – to control magnetic field separately in the gun and cooling regions.

+A.4 Measurements at several beam energies – cooling above transition is planned (according to Oliver).

-A.5 Measurements for several different Z – to confirm whether we have Z^2 dependence for rms ion velocities relevant for RHIC – all previous measurements are very consisitent – first need to understand what may be wrong in data interpretation/scaling

+ A.6 Use solenoidal correction coils to study dependence of cooling rate on the strength of magnetic field errors – "optimum imperfections?" - standard procedure

- B. Measurements of Transverse Cooling Force – not an easy/standard procedure- In principle, it's possible to discuss it.

+ C. Study of equilibrium between IBS and Cooling:

C.1. Estimate critical number of electrons needed for equilibrium based on rms Cooling and IBS rates. Estimate critical number based on detailed rates. Find critical number experimentally – possible:

C.1.a) By measuring emittance evolution before equilibrium is achieved.

C.1.b) Taking dependence of equilibrium emittance on electron current.

Requirements/questions for experiments:

1. **Well controlled experiment – availability of good diagnostic**
2. **Possibility to change and measure longitudinal temperature of electrons**
3. **Possibility to change and measure transverse temperature of electrons**
4. **Availability of a wide range for changing magnetic field.**
5. **Can we change cathode magnetic field and magnetic field in cooling section independently?**

It looks like the most relevant e-cooler ring for these experiments is ESR (GSI) which allows to make experiments for heavy ions, including Au ions. Also, it provides the largest range in available current of electron beam (0.5-5 A), electron energy (10-320 KeV) and solenoidal magnetic field (0.1-2.5 kG).